R E P O R T R E S U M E S

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REPORT OF FINDINGS AND RESULTS OF TECHNICAL EDUCATION CURRICULUM WORKSHOP (LOS ALAMOS, NEW MEXICO, AUGUST 7-11, 1967).

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AT THIS WORKSHOP OF INDUSTRIAL REPRESENTATIVE AND TECHNICAL EDUCATORS, A TECHNICIAN WAS DEFINED AS ONE WITH BROAD-BASED MATHEMATICAL AND SCIENTIFIC TRAINING AND WITH COMPETENCE TO SUPPORT PROFESSIONAL SYSTEMS, ENGINEERING, AND OTHER SCIENTIFIC PERSONNEL. HE SHOULD RECEIVE A RIGOROUS, 2-YEAR, POST SECONDARY EDUCATION ESPECIALLY DESIGNED FOR HIS NEEDS. INDUSTRY MEMBERS AGREED THAT HE MUST (1) UNDERSTAND THE TOTAL MANUFACTURING PROCESS IN HIS INDUSTRY, (2) BE ABLE TO COMMUNICATE WELL AND LEARN NEW DATA HANDLING PROCESSES WHEN NECESSARY, (3) KNOW SCIENTIFIC METHOD IN GENERAL AS WELL AS HIS SPECIALTY, (4) HAVE A SOLID BACKGROUND IN PERTINENT MATHEMATICS COURSES, AND (5) HAVE A GENERAL ABILITY TO WORK WITH BOTH THE TOOLS AND THE THEORY OF HIS PARTICULAR INDUSTRY. A COMPLETE CURRICULUM, WITH COURSE SEQUENCE AND DETAILED TEACHING PLAN, IS GIVEN FOR THE FOLLOWING--MECHANICAL DRAFTING AND DESIGN, ARCHITECTURAL AND STRUCTURAL DRAFTING AND DESIGN, CIVIL CONSTRUCTION, ELECTRONICS, ELECTRICAL, INSTRUMENTATION, AND MECHANICAL TECHNOLOGIES, AND DATA PROCESSING AND PROGRAMING. THE WORKSHOP CONCLUDED WITH SUGGESTIONS FOR ESTABLISHING A REGIONAL EVALUATION AND ACCREDITATION ASSOCIATION, TO INCLUDE A TECHNICAL SPECIALIST FROM EACH OF THE FIVE STATES IN THE REGION, AT LEAST THREE INDUSTRIAL REPRESENTATIVES FOR EACH TECHNOLOGY, THE STATE OFFICIAL IN CHARGE OF TECHNICAL EDUCATION, AND FEDERAL PERSONNEL FROM THE REGIONAL OFFICE OF THE U.S. OFFICE OF EDUCATION. (HH)

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Report of Findings & Results of Technical Education Curriculum Workshop

August 7-11, 1967

Los Alamos, New Mexico

TC 680 038

UNIVERSITY OF CALIF.
LOS ANGELES

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ACKNOWLEDGMENT

The curriculum materials that were developed in this workshop can be directly attributed to the many knowledgeable technical educators who participated in the week workshop. However, of additional significance is the fact that only through a U. S. Office of Education regional concept of organization could such a meeting be held.

Through such a regional structure, assistance can be provided in the area of technical education, and through the continuous and encouraging support of Mr. George D. Hann, Regional Assistant Commissioner, Region VII, this workshop was organized. If the necessary assistance for technical education in this region is to be provided, it can only be accomplished through this type of support.

Arthur Lee Hardwick

Overview

The results of the nine curriculum sections at the workshop have been finalized and are enclosed in this report. The basic purpose of the workshop was to develop realistic essential standards and goals of the nine technical education curriculums constituting the majority of diversified technical offerings established in the five states of Arkansas, Louisiana, New Mexico, Oklahoma, and Texas. The participants of the workshop worked toward the objective of providing the necessary guidelines for properly educating technicians to meet the needs of the industry of the Region. The participants concentrated on what the technician needs to know and what he must be able to do; the emphasis was placed on what was required in the educational program to accomplish this goal.

The selected panel members, industrial representatives, and participants at the workshop reflected the accumulated experience and knowledge of many successful programs and educational institutions in the technical field. Various viewpoints were presented regarding the role and scope of the technician; however, this was generally attributed to the individual's experience and relationship with specialized technical fields and could be generally expanded to a more general definition of the technicians' responsibilities. The viewpoints of the group were consolidated to strengthen the philosophical base and to establish a frame of reference in which to work, and from this consolidation the following general definition was developed.

Technician Definitions

Technicians are persons who have the mathematical and scientific knowledge and competencies to perform at a technical level and to support the performance of professional engineering, systems and

scientific personnel in certain recognized branches of technology. They are generally educated in a rigorous two-year post-secondary education program designed to provide them with knowledge, skills, and attitudes required to enable them to perform as highly skilled technicians in a specific field of applied science.

Specific Abilities of Technicians

The panel members, mainly the industrial representatives, discussed in the general session of the workshop what special abilities were generally required by techniciens; they generally agreed that the technician must be prepared to perform at the desired level with the specific abilities listed below: (In the order specified).

1. Understanding of the total manufacturing process involved in that industry. A thorough understanding and facility in use of the materials, processes, apparatus, procedures, equipment, methods, and techniques commonly used to perform the work and provide the specialized services required of the technology.

2. English, spelling, and communications skills background that includes the ability to record, analyze, interpret, and transmit facts and ideas with complete objectivity, orally, graphically, or in writing. Students must also have communications ability to master new forms of data and unique information systems necessary and pertinent to their field of specialization.

3. Applied knowledge of science extensively to provide direct technical assistance to professional personnel. Proficiency in the disciplined and objective scientific method in the application of the basic principles, concepts, and laws of the sciences as they comprise the base for the individual's field of specialization.

4. Facility with mathematics, ability to use algebra and trigonometry as tools in the development, definition, or qualifications of scientific phenomena or principles; and when needed, an understanding of, (though not necessarily facility with higher mathematics through analytical geometry, calculus, and differential equations), according to the requirements of the technology.

5. Provide a general "hands on" experience sufficiently extensive as to develop an understanding of the physical and economic restrictions in the manufacturing processes involved in modern industry.

With the general terminology and special abilities required of technicians studied, the nine curriculums were analyzed to formulate the total curriculum for each of the following areas:

1. Mechanical Drafting and Design Technology
2. Architectural and Structural Drafting and Design Technology
3. Civil Technology
4. Construction Technology (to be given further study and finalized at a later date)
5. Electronics Technology
6. Electrical Technology
7. Instrumentation Technology
8. Mechanical Technology
9. Data Processing Programming

The curriculums developed by the panels and participants are as follows:

MECHANICAL DRAFTING & DESIGN TECHNOLOGY

FIRST YEAR

First Semester	Theory	Lab	Credit
Technical Drafting I	2	6	4
Materials of Industry	3	3	4
Engineering Problems	1	3	2
College Algebra & Trigonometry	5	0	5
Communication Skills I	3	0	3
			18

Second Semester			
Technical Drafting II	1	6	3
Descriptive Geometry	1	3	2
Mechanisms	2	0	2
Statics & Mechanics of Materials	4	3	5
Analytics and Calculus	5	0	5
			17

SECOND YEAR

First Semester			
Technical Drafting III	2	9	5
Machine Design I	2	3	3
Physics	3	3	4
Government	3	0	3
Introduction to Computers	3	0	3
			18

Second Semester			
Technical Drafting IV	2	6	4
Machine Design II	2	6	4
Technical Report Writing	3	0	3
Principles of Management	3	0	3
Social Science	3	0	3
			17

COURSE DESCRIPTIONS

Technical Drafting I--This course is designed to aid the student in developing an understanding of the basic principles of orthographic and axonometric projection.

Special care is taken to provide exercises in the care and use of equipment and mechanical and freehand lettering.

The ability to produce accurate and complete detail and assembly working drawings as well as an elementary understanding of design principles, underlining drafting, is essential and exercises are provided to develop skill and understanding in these areas.

The principles of descriptive geometry are applied throughout the course and simplified drafting practices are introduced.

Established standards are stressed, experience is gained in using handbooks and other resource materials, and the interpretation of industrial sketches and prints are introduced when feasible.

Materials of Industry and Manufacturing Processes--Modern industry utilizes a variety of engineering materials with which the student in mechanical drafting and design technology must be familiar. A study is made of the ferrous metals, nonferrous metals, wood products, nonmetallic materials, miscellaneous materials and their application to industrial uses. Special emphasis is given to new materials which have been developed through technological advances.

It is also designed to develop an understanding of present-day manufacturing processes and is of extreme importance to students in this technology. This course is designed to provide a background of knowledge covering the various manufacturing materials and the fundamental types of manufacturing methods as employed in cold working processes. Through lecture, demonstration, and practical applications the student is given the opportunity to become familiar with the various types of machine tools, tooling, measuring, and inspection procedures. Automation is introduced and information is presented to acquaint the student with the modern practices of numerical control for machine tools and the uses of transfer and special machines.

Engineering Problems--This course is a detailed study made of various production activities and the problems associated with them. Problems and cases are solved through the use of available data in texts and engineering handbooks. Discussion of each topic begins with a consideration of the nature of the problem and continues with a presentation of the detailed approach to be employed in its solution. Some problems deal with the analysis of the elements of production scheduling. Others deal with methods of determining production costs in terms of labor, material, and burden. Balancing work stations on production lines by graphic, as well as by mathematical means to achieve constant flow and calculating machine capacities to establish completion dates represent a major portion of the laboratory work. Simulated industrial office atmosphere permits student groups representing various departments and functions of production to work cooperatively to achieve common objectives. Constant use of blueprints throughout the course strengthens the ability of the student to visualize and to interpret them. The basic slide rule operations are introduced early in the course so that the student can use this tool to advantage in other courses.

Course Descriptions (continued)

College Algebra & Trigonometry--This course assumes the satisfactory completion of a minimum of one-semester of high school algebra and is the first of two mathematics courses designed specifically for mechanical drafting and design technology. An integrated course in college algebraic and trigonometric problems that have direct practical application to the field of specialization will be utilized.

Communication Skills I--This course places emphasis throughout on exercises in writing, speaking, and listening. Analysis is made of each student's strengths and weaknesses. The pattern of instruction is directed principally to helping students improve skills in areas where common weaknesses are found. The time allotments for the various elements within major divisions will depend upon the backgrounds of the individuals in the class.

Technical Drafting II--This course provides additional understanding of drafting problems, skills and techniques that are essential to the work of the draftsman. Introduction is given to several specialized drafting areas that are equally valuable in preparation for design work. The units in the course dealing with parts such as gears, cams, jigs, and fixtures pave the way for greater depth of instruction in the second year design courses.

Descriptive Geometry--This course is the study of the projection of points, lines, and planes with applications to practical problems. The intersections, revolutions, developments, tangencies, and piercing points of lines, planes, and geometric shapes are also studied.

Mechanics--A course dealing with the analysis of the motion characteristics of a mechanism or existing design of a mechanism to provide desired motion characteristics. In the motion study, absolute and relative velocities, accelerations, and the use of instant centers are discussed. Centrodes are studied as they apply to mechanism. The uses of belts and linkages are illustrated by problems. Cam layout is taken up in detail and appropriate problems are solved. Practical problems are used in the study of gearing. Attention is also given to such mechanisms as ratchets, pantographs, valves, clutches, and universal joints.

Statics and Mechanics of Materials--This course is designed to develop a knowledge of the underlying principles of analytical mechanics. The student should understand the basic laws of statics and dynamics. The study of the geometry of motion (kinematics), and the study of the forces required to produce motion (kinetics), must be involved. Study is made of the internal stresses and deformation of elastic bodies resulting from the action of external forces. The application of this principle of strength of materials is considered fundamental in the design of structures and machines. Emphasis is given to the analysis of the simple and combined stresses and properties of materials to meet the functional requirements in design. In this course, strength of such elements as riveted joints, beams, columns, shafts, and keys are determined.

Course Descriptions (continued)

Analytics & Calculus--This course is a study of rectangular coordinates, the straight line and the conic sections, polar coordinates and general equation of the second degree. Introduction to analytical geometry of three dimensions. Trigonometry and algebra are continued and expanded to more advanced phases as required in the technology. Calculus is incorporated in a manner emphasizing concept and principle rather than facility in manipulation.

Technical Drafting III--This course helps the student gain knowledge and experience necessary to design tools commonly used in modern manufacturing. The work consists of designing and laying out cutting tools, gauges, simple jigs, fixtures, and dies. Mass production methods are discussed, analysis of manufacturing costs, economic selection of machine equipment, tool economy and economic processing. Processing details such as tool layout and quality control, estimating production costs and the economics of machine and tool replacement are discussed.

Machine Design I--This course provides exercises in advanced drafting room practices where the student applies his knowledge of mathematics, science, and drawing to practical problems in the design of component parts of a machine. He analyses the problems, gathers data, sketches his ideas on paper, does all necessary mathematical calculations, makes working drawings, and finally checks his work. Consideration is given throughout to factors which influence the design such as the methods of manufacture, properties of materials, and conditions of product and manufacturing economy. The machine elements designed will be analyzed in regard to the functional requirements, geometry of design, and cost of manufacture. Attention is given to calculating load factors, deformations, critical accuracies, and the operative dynamics of numerous machine elements.

Physics--This course is designed to develop an understanding of the principles of electricity, electricity circuitry, and equipment with emphasis on the concepts of electrical physics. The treatment of this subject as a mathematics-based science provides a basis for future study for those students who will require a greater depth of understanding in this area.

Government--The course is oriented to the proposition that each technician in a democracy has a responsibility to make a productive contribution toward the perfection and perpetuation of the American way of life; and that, to do so, he must know and understand his responsibilities and obligations to himself, his family, his community, his State and Nation, and the world. The elements of government are reviewed to help the student achieve a good working understanding of his total environment and the forces which interact to form the social setting in which he works and lives.

Introduction to Computers--This course introduces the fundamental principles of digital and analog computers. With the wide applications and implications of computer systems, it is important that the mechanical drafting and design students understand computer principles. As the study proceeds from the simple computer to the complex installations which are becoming parts of control systems, it is necessary to consider the possibilities and the limitations of various types of computers. It is also necessary to become familiar with auxiliary equipment, such as input-output devices, analog-to-digital converters, data storage components, and types of switching and conversion apparatus which have become part of some modern systems.

Course Descriptions (continued)

Technical Drafting IV--This should be a course in electro-mechanical drafting where study is made of automated units, electronically controlled mechanical assembly line equipment, and ADM (automatic discharge machining) units. A study of power distribution systems is included and a study of hydraulically operated, pneumatically operated, and electrically operated units.

Machine Design II--This course will be involved with the initial planning of machines, and fundamental decision making concerning loading, type of kinematic elements to be used, and correct utilization of the properties of engineering materials. Economic considerations (of the design of new machinery) will be studied. Consideration should be given not only to the cost of design, manufacture, sale, and installation, but also to the cost of servicing. The course should also study the safety features of the machine. In general the course will incorporate a rational method of design attempts to take the results of relatively simple and fundamental tests such as tension, compression, torsion, and fatigue and apply them to all the complicated and involved situations encountered in present-day machinery.

Technical Report Writing--This course emphasis is upon techniques for collecting and presenting scientific data by means of informal and formal reports and specific types of technical papers. Forms and procedures for technical reports are studied, and a pattern is established for all forms to be submitted in this and other courses.

Principles of Management--This course is a study of the basic principles and practices of management. It discusses the relationships of economic factors of industry as they relate to labor and management.

Social Scienee--A description and analysis of the roles played by labor and management in the economy of the United States is presented. Approximately one-half of the classroom time is devoted to labor-management relations, including the evolution and growth of the American labor movement and the development and structure of American business management. A study is made of the legal framework within which labor-management relations are conducted and the responsibilities of each in a democratic system of government. The second half of the course pertains to labor-economics as applied to the forces affecting labor supply and demand, problems of unemployment reduction and control, and wage determination on the national, plant, and individual levels. Emphasis centers upon current practical aspects of our industrial society with historical references intended only as background material to interpret trends and serve as points of departure.

ARCHITECTURAL AND STRUCTURAL DRAFTING AND DESIGN TECHNOLOGY

FIRST YEAR

First Semester	Theory	Lab	Credit
Architectural Drafting Fundamentals	2	6	4
Construction Materials	3	0	3
Technical Mathematics I	4	0	4
Communication Skills I	3	0	3
History	3	0	3
			17

Second Semester			
Architectural Drafting I	2	6	4
Descriptive Geometry	2	3	3
Technical Mathematics II	4	0	4
Physics	3	3	4
Communication Skills II	3	0	3
			18

SECOND YEAR

First Semester			
Architectural Drafting II	2	6	4
Construction Estimating	3	0	3
Structural Analysis (Statics, Mechanics and Strength of Materials)	5	0	5
Government	3	0	3
Structural Drafting	1	6	3
			18

Second Semester			
Architectural Drafting III	2	6	4
Codes, Specs, and Contracts	3	0	3
Building Equipment (Mechanical)	3	0	3
Architectural Structures	3	3	4
Economics	3	0	3
			17

COURSE DESCRIPTIONS

First Semester--FIRST YEAR

Architectural Drafting Fundamentals--This course is designed to provide fundamental knowledge of the principles of drafting concentrating the examples, illustrations, and assignments to architectural working drawing when feasible. Use of drawing equipment, lettering, freehand sketching, geometric construction, and orthographic instrument drawing of principal views, are stressed.

Construction Materials--This course is designed to study architectural and structural construction methods and materials, their nature and use, and equipment as used in general. The method and type of manufacture will be considered along with cost and feasibility of use.

Technical Mathematics I--This course is designed to study algebraic operations, the rectangular coordinate system as well as trigonometric concepts. The real number system is developed as an extension of natural numbers. The basic slide rule operations are introduced early in the course so that the student can use this tool to advantage in other courses.

Communication Skills--This course places emphasis throughout on exercises in writing, speaking, and listening. Analysis is made of each student's strengths and weaknesses. The pattern of instruction is directed principally to helping students improve skills in areas where common weaknesses are found. The time allotments for the various elements within major divisions will depend upon the backgrounds of the individuals in the class.

History--This course is a study of the development of American political, social, and economic democracy. The American constitutional system including the Federal Constitution and State Constitutions will be studied including federal and state legislative structure and policy.

Second Semester

Architectural Drafting I--This course is designed to study the development and techniques for the preparation of working drawings. Elements of construction and planning of buildings; methods of representing architectural drawing and plans, elevations and details of light construction are studied.

Descriptive Geometry--This course is the study of the projection of points, lines, and planes with applications to practical problems. The intersections, revolutions, developments, tangencies and piercing points of lines, planes and geometric shapes are also studied.

Technical Mathematics II--This course continues and expands to more advanced phases of trigonometry, analytic geometry, and algebra as the technology requires. Graphical analysis is used wherever possible. Practical problems illustrate the principles involved and the utility of mathematics in technical study. Calculus is introduced in a manner emphasizing concept and principles rather than facility in manipulation.

Course Description (Continued)

Physics--This course deals with the application of scientific principles to technical and industrial use and the structure of matter, mechanics and heat. The scientific principles have direct application to the technical specialty.

Communications Skills II--The nature and dynamics of communications are continued in this course. The fundamental concepts treated here have important implications for organizations of all types--business, industry, government, military, social, public, and civic. This course is devoted to the practical use of the communication process within the industry and, in particular within the architectural field.

First Semester--SECOND YEAR

Architectural Drafting II--This course involves drawing of plans and details for building construction. Reference materials will be used to provide the draftsman with skills and knowledge in locating data and in using handbooks.

Construction Estimating--This course is a study of the preparation of materials and labor quantity surveys, approximate and detailed estimates of cost. The study will include materials take-off, labor take-off, sub-contractor's estimates, overhead costs, and bid and contract procedures.

Structural Analysis--(Statics, Mechanics, & Strength of Materials)--This course is a combination of statics, mechanics, and strength of materials. It combines mechanics using the vector method, stress, strain, and elasticity of materials.

Government--The course is oriented to the proposition that each technician in a democracy has a responsibility to make a productive contribution toward the perfection and perpetuation of the American way of life; and, to do so, he must know and understand his responsibilities and obligations to himself, his family, his community, his State and Nation, and the world. The elements of government are reviewed to help the student achieve a good working understanding of his total environment and the forces which interact to form the social setting in which he works and lives.

Structural Drafting--This course is a study of materials such as beams and columns, etc. Development of structural plans, details and shop drawings of components of buildings to include steel, reinforced concrete, and timber.

Second Semester

Architectural Drafting III--This course involves the preparation of the complete set of working drawings for the architectural structure. Preparation of millwork drawings, cabinets and built-in equipment detail drawings, and door, window and room schedules.

Codes, Specifications, and Contracts--This course is a study of building codes and their effect in relation to specifications and drawings. Specifications will be studied along with their legal and practical application to working drawings.

Course Descriptions (continued)

Building Equipment (Electrical & Mechanical)--This course is a general study of heating, air conditioning and plumbing equipment, materials, and symbols. The study of electrical drawings, symbols, and diagrams is also included. Coordination of electrical requirements with structural architectural and mechanical requirements will be stressed.

Architectural Structures--This course is a study of analytical and graphical analysis of determinate structures.

Economics--This course is a description and analysis of American economic institutions and principles. It is an institutional study of the American economy with special attention given to its control and stability.

CIVIL TECHNOLOGY

FIRST YEAR

First Semester	Theory	Lab	Credit
Technical Drafting I	1	6	3
Materials of Construction & Testing	2	3	3
Orientation	1	0	1
Construction Methods & Equipment	3	0	3
Technical Mathematics I	5	0	5
Communication Skills I	3	0	3
			18

Second Semester			
Surveying & Measurements	1	6	3
Descriptive Geometry	2	3	3
Physics & Engineering Problems	2	6	4
Technical Mathematics II	5	0	5
Introduction to Technical Communications	3	0	3
			18

SECOND YEAR

First Semester			
Highway Design & Construction	2	3	3
Estimating	3	0	3
Surveying & Photogrammetry	2	6	4
Statics, Mechanics & Strength of Materials	5	0	5
Government	3	0	3
			18

Second Semester			
Route Design & Surveys	2	3	3
Contracts, Specifications & Bids	3	0	3
Structural Mechanics	2	3	3
Hydraulics	3	0	3
Economics	3	0	3
Technical Report Writing	3	0	3
			18

COURSE DESCRIPTIONS

Technical Drafting I--This course is an introductory course in engineering drawing and geometry. Use of instruments, orthographic projection, lettering, sectional views and auxiliary projections, and applied engineering geometry are studied to develop drafting and drawing knowledge and skills. Practice in these skills follows in studies of fasteners, dimensioning, and working and assembly drawings. A brief survey of pictorial sketching and drawing and making charts and diagrams is included.

Materials of Construction & Testing--This course is a study of materials used in industry and construction. Sources and methods of manufacture are covered briefly with properties and factors affecting selection emphasized. Standard tests and experimental verification of theory are performed in the laboratory.

Orientation--This course is a study of the interrelationships of the technician, scientist, and the engineer, along with the work, salary, and goals of the engineering technologists.

Construction Method and Equipment--This course is an introductory study of methods to determine quantities of materials, equipment, labor, and money required for construction projects. It includes characteristics and capabilities of work equipment,methods of obtaining unit costs of in-place construction, and field reporting practices and responsibilities of field inspection.

Technical Mathematics I--This course is the first course in a two-semester sequence of integrated mathematics covering selected topics in algebra, trigonometry, analytical geometry, and calculus.

Communication Skills I--This course places emphasis throughout on exercises in writing, speaking, and listening. Analysis is made of each student's strengths and weaknesses. The pattern of instruction is directed principally to helping students improve skills in areas where common weaknesses are found. The time allotments for the various elements within major divisions will depend upon the backgrounds of the individuals in the class.

Surveying & Measurements--This course is an elementary course in surveying, including the fundamentals of plane surveying and the use and care of equipment. Accurate measuring of distance, theory and practice of leveling, angles and bearings, principles and use of the transit, curves, stadia, and topographic and land surveying are studied in coordinated class, laboratory, and field assignments. A brief introduction to the U.S. Public Lands System is included near the conclusion of the course. Special emphasis is placed on note-keeping and computations.

Descriptive Geometry--This course is the study of the projection of points, line and planes with applications to practical problems. The intersections, revolutions, developments, tangencies and piercing points of lines, planes, and geometric shapes are also studied.

Physics & Engineering Problems--This course covers the basic principles of mechanics applied to solid particles and to fluids. It gives the student an introduction to the scientific method. The basic slide rule operations are introduced early in the course so that the student can use this tool to advantage in other courses.

Course Descriptions (continued)

Technical Mathematics II--Second course in a two-semester sequence of integrated mathematics covering selected topics in algebra, trigonometry, analytical geometry, and calculus.

Introduction to Technical Communication--This course is a natural extension of the course in Communication Skills intended to help the student achieve greater facility in the basic skills previously acquired. The student is introduced to the practical aspects of preparing reports and communicating within groups. The use of graphs, charts, sketches, diagrams, and drawings to present ideas and significant points is an important part of this course.

Highway Design & Construction--This course is concerned with the elements of a transportation roadway and their functions: Roadway foundations; pavement types, characteristics, composition, and structural design; construction procedures; and characteristics of railroad tracks and beds.

Estimating--This course is an introduction to estimating and construction, practice to familiarize the student with the construction process as a whole, the ways in which contractors organize their offices to accomplish a job of construction, the generation of plans and specifications and their use, systems of accounting,and how material quantity "take-off" forms the basis for accounting. Critical-path method of planning and scheduling is studied intensively to teach this increasingly important technique.

Surveying & Photogrammetry--This course is a continuation of the study of surveying. It also devotes time to the obtaining of surveys by means of photography. Specifically the course deals with the process of making maps from standard surveying techniques, photographs, and aerial photographs.

Statics, Mechanics, & Strength of Materials--This course is a combination of statics, mechanics, and strength of materials. It combines mechanics using the vector method, stress, strain, and elasticity of materials.

Government--The course is oriented to the proposition that each technician in a democracy has a responsibility to make a productive contribution toward the perfection and perpetuation of the American way of life; and , to do so, he must know and understand his responsibilities and obligations to himself, his family, his community, his State and Nation, and the world. The elements of government are reviewed to help the student achieve a good working understanding of his total environment and the forces which interact to form the social setting in which he works and lives.

Course Descriptions (continued)

Route Design & Surveys--This course in highway route design is concerned with the effects of traffic and vehicular characteristics on road design, length of highway, curvature and elevation of roadbeds as they affect costs and location, geometric design, field and office practice in route and curve layout, earthwork computations, and the principles of aerial photography applied to highway route design.

Contracts, Specifications, and Bids--This course is an introductory study of legal relations and the economic problems in engineering work, such as specifications, bidding procedures, bonding, letting, awarding of contracts, torts, negligence, trespass to real estate, violation of the right of lateral support, Workman's Compensation, and agency, master-servant, and employee injuries. It covers the law of real property, ownership, easements, licenses, boundaries, and eminent domain.

Structural Mechanics--This course studies analysis and design of simple frames by approximate determinate methods, moment distribution, and slope deflection.

Hydraulics--This course is a study of the basic components of hydraulic systems and how they are combined to build up various circuits.

The emphasis is on the use of hydraulics for power transmission and for control purposes. The hydraulics area is treated as a basic science with emphasis on mathematical analysis and the scientific method.

Economics--This course is a description and analysis of American economic institutions and principles. It is an institutional study of the American economy with special attention given to its control and stability.

Technical Report Writing--This course emphasis is upon techniques for collecting and presenting scientific data by means of informal and formal reports and specific types of technical papers. Forms and procedures for technical reports are studied and a pattern is established for all forms to be submitted in this and other courses.

ELECTRONICS TECHNOLOGY

FIRST YEAR

First Semester

D. C. Theory & Lab	3	3	4
Electronic Devices	2	3	3
Technical Mathematics I (Algebra and Trig.)	5	0	5
Orientation	1	0	1
Communication Skills	3	0	3
			16

Second Semester

A. C. Theory & Circuit Analysis	3	3	4
Transistors & Vacuum Tubes	3	3	4
Physics	3	3	4
Technical Mathematics II (Applied Analytics)	3	0	3
Technical Report Writing	3	0	3

SECOND YEAR

First Semester

Electronic Test Instruments	3	3	4
Electronic Circuits	3	3	4
lectronic Systems	2	6	4
Technical Mathematics III (Applied Calculus)	3	0	3
History	3	0	3
			18

Second Semester

Advanced Semi-Conductors	3	3	4
Advanced Project Research Report	3	0	3
Government	3	0	3
*Industrial Control Circuits	3	3	4
*Computer Fundamentals & Circuits	3	3	4
			18

*Optional courses for fourth semester of Electronics Technology curriculum. The courses can be selected on the basis of local industrial needs.

1. Servo-Mechanics
2. Micro-Wave
3. Communications
4. Computer Circuits

COURSE DESCRIPTIONS

D. C. Theory & Lab--This course presents an introduction to electrical theory on the basis of direct current with an emphasis on contemporary techniques as a supplement to basic concepts. It covers the principles of electron physics, unidirectional current and factors affecting its magnitude, series circuit analysis, parallel-circuit analysis, series parallel-circuit analysis, complex unidirectional current circuit, and the phenomenon of magnetism.

Electronic Devices--This course is an introduction to electronic hardware and its elementary use. It provides the foundation for later courses in electronic circuits and systems by teaching the operational characteristics of electronic devices and by introducing the basic principles and processes involved in each class of devices. Topics studied include the semi-conductor diode and the junction transistor, vacuum tubes, gas tubes, photo-electric devices, zener diodes, and tunnel diodes. These devices are treated in terms of their static characteristics, the loan line method of analysis is introduced, and incremental input-output relationships are considered.

Technical Mathematics I (Algebra & Trig.)--This course is the first in a three-semester sequence of integrated mathematics covering selected topics in algebra, trigonometry, analytical geometry, and calculus. This first course in mathematics must be designed to insure that the student has the mathematics necessary to understand and work with the principles covered in the technical courses.

Orientation--This course is a study of the interrelationships of the technician, scientist and the engineer--work, salary, and goals of the engineering technologist.

Communication Skills I--This course places emphasis throughout on exercises in writing, speaking, reading and listening. Analysis is made of each student's strengths and weaknesses. The pattern of instruction is directed principally to helping students improve skills in areas where common weaknesses are found. The time allotments for the various elements within major divisions will depend upon the backgrounds of the individuals in the class.

A. C. Theory & Circuit Analysis--This course is a continuation of electrical theory on the basis of alternating currents with an emphasis on newer techniques as a supplement to basic concepts. The analysis of the sine wave, series circuit with sine wave input, series resonance, parallel circuits with sine wave inputs, parallel resonance, and the nonresonant and the resonant transformer.

Transistors & Vacuum Tubes--This course is designed as an introduction of vacuum tubes and transistors, fundamentals, construction, and static and dynamic characteristics. A study will be made of multi-section and special purpose tubes. Semi-conductor devices such as diodes, transistors, and photo transistors will be studied.

Physics--The aim of this course is not only to convey a knowledge of facts and fundamental theories but also to provide training in the ability to apply such knowledge to the solution of real problems. Mechanics and basic mechanical systems are emphasized since many modern electrical and electronic devices are electro-mechanical combinations. The mechanics of fluids and the elements of heat are introduced to broaden the base of the student's understanding of physical phenomena he will encounter as an employed electronic technician.

Course Descriptions (continued)

Technical Mathematics II (Applied Analytics)--This course is the second in a three-semester sequence of integrated mathematics covering selected topics in algebra, trigonometry, analytical geometry, and calculus. The student studies analytic geometry which should be closely correlated with electronic courses.

Technical Report Writing--This course emphasis is upon techniques for collecting and presenting scientific data by means of informal and formal reports and specific types of technical papers. Forms and procedures for technical reports are studied, and a pattern is established for all forms to be submitted in this a d other courses.

Electronic Test Instruments--A study of electrical measurement and instrumentation devices, transducers, and elements and the principles underlying their design, use, and relationships. It begins with the mathematical study of probability and error analysis followed by consideration of the nature and source of errors in measurement and the performance of electrical and electronic instruments. This is followed by a study of specific devices and measuring instruments or classes of measuring devices including basic AC and DC measurement meters, transducers, oscilloscopes, signal generators, tube and transistor testers, and concludes with a study of audio frequency and radio frequency test methods and equipment.

Electronic Circuits--A study of Electronic Circuits leading to the development of amplifiers, oscillators, multivibrators, simple control devices, and types of modulators. Laboratory experiences will emphasize methods of testing and modifying these circuits. Studying output wave shapes resulting from various input signals, and component substitution, will be stressed. Frequency response in all circuits will be considered.

Electronic Systems--A study of electronic circuits combined into a complete electronic system. Signal tracing, schematic diagram interpretation and trouble shooting techniques will be introduced in this course.

Technical Mathematics III (Applied Calculus)--This course is the third in a three-semester sequence of selected topics in algebra, trigonometry, analytical geometry, and calculus. (The student studies both differentiation and integration and applies their usage to technical problems.) The course concludes with an introduction to Fourier analysis as it applies to an electronic problem.

History--This course is designed to provide the student with some historical perspective for understanding the economic, political, and social institutions of modern society. In this context, emphasis will be placed upon U.S. and State history and constitutional development.

Course Descriptions (continued)

Advanced Semi-Conductors--This course is designed as a continuation of the study of semi-conductors. It will be utilized to study the new techniques involved in the development of semi-conductor devices such as photo transistors and solid logic printed circuits.

Advanced Project Research Report--This course involves a supervised research project consisting of design, layout construction and calibrating, and a major electronics project. Students will utilize all tools and equipment available.

Government--The course is oriented to the proposition that each technician in a democracy has a responsibility to make a productive contribution toward the perfection and perpetuation of the American way of life; and to do so, he must know and understand his responsibilities and obligations to himself, his family, his community, his State and Nation, and the world. The elements of government are reviewed to help the student achieve a good working understanding of his total environment and the forces which interact to form the social setting in which he works and lives.

Industrial Control Circuits--This course investigates the various control circuits commonly employed in industry. Principles of sino and data transmission systems with emphasis on fundamentals are presented.

Computer Fundamentals & Circuits--This course introduces the analog and digital computer, covers the operational amplifier, and illustrates how analog computers may be used for the solution of differential equations. Binary arithmetic is covered, and the elements of Boolean algebra are taught as a means of introducing digital computer ideas. Circuits used in digital computers are discussed and, finally, simple systems of circuits capable of performing logic operations are covered. It is imperative that electronic technicians be familiar with the principles of both digital and analog computers and the circuits employed in these devices.

ELECTRICAL TECHNOLOGY

FIRST YEAR

First Semester	Lecture	Lab	Credit
D. C. Theory & Lab	3	3	4
Technical Mathematics I	5	0	5
Orientation	1	0	1
Technical Drafting	2	6	4
Communication Skills	3	0	3
			17

Second Semester			
A. C. Theory & Lab	3	3	4
Power Systems Control & Switching	3	3	4
Technical Mathematics II	3	0	3
Physics	3	3	4
Technical Report Writing	3	0	3
			18

SUMMER SESSION

Studies to meet specific requirements of States and Institutions (Government and History) to be included during the summer.

SECOND YEAR

First Semester			
Electrical Control Systems	3	3	4
Electrical Power Supply & Amplifier	3	3	4
Electrical Machines	3	3	4
National Electrical Codes	3	0	3
Electrical Drafting & Design	2	3	3
			18

Second Semester			
Electrical Power Distribution	3	3	4
Electrical Installation & Planning	3	3	4
Industrial Electronics	3	3	4
Industrial Relations	3	0	3
Operating Problem Analysis	2	3	3
			18

COURSE DESCRIPTIONS

D. C. Theory & Lab--This course presents an introduction to electrical theory on the basis of direct current with an emphasis on contemporary techniques as a supplement to basic concepts. It covers the principles of electron physics, unidirectional current and factors affecting its magnitude, series circuit analysis, parallel-circuit analysis, series parallel-circuit analysis, complex unidirectional current circuit, and the phenomenon of magnetism.

Technical Mathematics I--This course is the first in a two-semester sequence of integrated mathematics covering selected topics in algebra, trigonometry, and analytical geometry. This first course in mathematics must be designed to insure that the student has the mathematics necessary to understand and work with the principles covered in the technical courses. The basic slide rule operations are introduced early in the course so that the student can use this tool to advantage in other courses.

Orientation--This course is a study of the interrelationships of the technician, scientist, and engineer, and the work, salary, and goals of the engineering technologist.

Technical Drafting--An elementary course designed for students having limited drawing experience. Use of templates, including lettering templates; fundamentals of drawing and drafting room practices; electrical circuit drawing, terms, symbols, and standards. All symbols used are those established by the U.S. Bureau of Standards. Students are cautioned that adaptation of standard symbols to special symbols used by future employers may be necessary. Emphasis is placed on construction and interpretation of typical industrial drawings.

Communication Skills--This course places emphasis throughout on exercises in writing, speaking, and listening. Analysis is made of each student's strengths and weaknesses. The pattern of instruction is directed principally to helping students improve skills in areas where common weaknesses are found. The time allotments for the various elements within major divisions will depend upon the backgrounds of the individuals in the class.

A. C. Theory & Circuit Analysis--This course is a continuation of electrical theory on the basis of alternating currents with an emphasis on newer techniques as a supplement to basic concepts. The analysis of the sine wave, series circuit with sine wave input, series resonance, parallel circuits with sine wave inputs, parallel resonance, and the nonresonant and the resonant transformer.

Power Systems Control & Switching--This course is an introduction to the technical concepts of electronic components and circuits. Principles of vacuum tubes and transistors; tuned circuits and basic circuits for power supplies, detectors, amplifiers, and oscillators; radio receivers; cathode-ray oscilloscopes; use of basic test devices and measuring instruments.

Technical Mathematics II--This course is the second and last in a two-semester sequence of integrated mathematics covering selected topics in algebra, trigonometry, and analytical geometry. The student studies analytic geometry. This should be closely correlated with electronic courses.

Physics--The aim of this course is not only to convey a knowledge of facts and fundamental theories but also to provide training in the ability to apply such knowledge to the solution of real problems. Mechanics and basic mechanical systems are emphasized since many modern electrical and electronic devices are electro-mechanical combinations. The mechanics of fluids and the elements of

heat are introduced to broaden the base of the student's understanding of physical phenomena he will encounter as an employed electronic technician.

Technical Report Writing--This course emphasis is upon techniques for collecting and presenting scientific data by means of informal and formal reports and specific types of technical papers. Forms and procedures for technical reports are studied and a pattern is established for all forms to be submitted in this and other courses.

Electrical Control Systems--The principles and applications of electrical controllers are covered in this course, which serves as an introduction to automation. Devices for differentiation, integration, and proportioning are studied in detail. Hardware and circuitry for AC and DC industrial control devices including contactors, starters, speed controllers, time delays, limit switches, and pilot devices are studied. Application in the control of industrial equipment-motors, servo units, and motor-driven actuators are also considered. Laboratory demonstrations and field trips are provided.

Electrical Power Supply & Amplifiers--This course is a study of energy-conversion devices used in the electrical field, AC and DC motors, AC and DC generators, motor starters, switches, circuit breakers, synchros and servo-mechanisms, and poly-phase equipment. Also studied will be the analysis and design of multistage transistor and vacuum tube amplifiers including compensation techniques and feedback principles.

Electrical Machines--The work in this course is confined to a study of mechanical-electrical power devices. Alternators, single-phase motors and three-phase motors, transformers, voltage regulators, generators, as well as the auxiliary control equipment necessary for these devices are studied. Laboratory work consists mainly of running load tests on selected equipment and studying the characteristic behavior of these units under varying operating conditions. Installation and maintenance requirements for alternating current power equipment are given some attention.

National Electrical Codes--This course is designed to examine the National Electric Code, National Safety Code, and laws governing electrical installations.

Electrical Drafting & Design--This course introduces the various types of electrical drafting used in the design and construction of equipment and structures. Study is made of the symbols, conventions, layout procedures, and circuit sequence that comprise an electrical circuit. Preparation of wiring diagrams and schematics using electrical and electronic symbols and component parts lists.

Electrical Power Distribution--This course is a study of the design, operation and technical details of modern power distribution systems including generating equipment, transmission lines, plant distribution, and protection devices. System loan analysis, rates, and power economics are studied.

Course Descriptions (continued)

Electrical Installation & Planning--This course covers methods and materials used in electrical installations and problems encountered in electrical construction work. Wiring materials include those in the National Electric Code.

Industrial Electronics--This course covers application of electronics to the control of power equipment. The basic circuits, control elements and hardware of controls are used to acquaint the student with circuit applications. The emphasis is on circuit theory and operation, limiting variables, and response characteristics of the typical industrial control equipment.

Industrial Relations--This course is designed to acquaint the student with industrial organizations and practices. It provides detailed information on the technical duties and responsibilities of the various types of technical and supporting manpower. Industrial speakers from various types of organizations will be involved in the course.

Operating Problem Analysis--A study is made of the proper procedures to be used in testing for troubles of electrical systems and their correction. The methods used in setting up and supervising a program of preventive maintenance, trouble-shooting, equipment receiving, data recording, and cost accounting are also studied.

INSTRUMENTATION TECHNOLOGY

FIRST YEAR

First Semester	Lecture	Lab	Credit
D. C. Theory and Circuit Analysis	3	3	4
Introduction to Standards	3	3	4
Instrument Shop Practice	0	6	2
Technical Mathematics I	5	0	5
Communication Skills I	3	0	3
			18

Second Semester			
A. C. Theory and Circuit Analysis	3	3	4
Principles of Industrial Measurements	3	3	4
Semi-Conductors & Vacuum Tubes	3	3	4
Physics for Instrumentation I	3	3	4
Technical Mathematics II	3	0	3
			19

SUMMER SESSION

Studies to meet specific requirements of States and Institutions (Government and History) to be included during the summer.

SECOND YEAR

First Semester			
Principles of Automatic Controls	3	3	4
Computer Principles & Controls	3	3	4
Physics for Instrumentation II	3	3	4
Technical Mathematics III	3	0	3
Technical Report Writing	3	0	3
			18

Second Semester			
Analytical Measurements	3	3	4
Advanced Automatic Controls	3	3	4
Electrical Power Supply & Amplifiers	3	3	4
Instrumentation Project	1	3	2
Chemistry for Instrumentation	3	3	4
			18

COURSE DESCRIPTIONS

D. C. Theory & Circuit Analysis--This course presents an introduction to electrical theory on the basis of direct current with an emphasis on contemporary techniques as a supplement to basic concepts. It covers the principles of electron physics, unidirectional current and factors affecting its magnitude, series circuit analysis, parallel-circuit analysis, series parallel-circuit analysis, complex unidirectional current circuit, and the phenomenon of magnetism.

Introduction to Standards--This course is designed to illustrate the philosophy of measurement and control emphasizing the standards and needs for standards in the field of instrumentation. It also stresses the meaning of validity, sensitivity of control devices, units of measurement, and levels of accuracy and traceability.

Instrument Shop Practices--A laboratory course designed to provide practical information on the application of basic theories to commercial instruments; instrument construction, tests, and accepted test procedures; and safety precautions which must be observed when working on instruments.

Technical Mathematics I--This course is the first in a three-semester sequence of integrated mathematics covering selected topics in algebra, trigonometry, analytical geometry, and calculus. This first course in mathematics must be designed to insure that the student has the mathematics necessary to understand and work with the principles covered in the technical courses. The basic slide rule operations are introduced early in the course so that the student can use this tool to advantage in other courses.

Communication Skills I--This course places emphasis throughout on exercises in writing, speaking, and listening. Analysis is made of each student's strengths and weaknesses. The pattern of instruction is directed principally to helping students improve skills in areas where common weaknesses are found. The time allotments for the various elements within major divisions will depend upon the backgrounds of the individuals in the class.

A. C. Theory & Circuit Analysis--This course is a continuation of electrical theory on the basis of alternating currents with an emphasis on newer techniques as a supplement to basic concepts. The analysis of the sine wave, series circuit with sine wave input, series resonance, parallel circuits with sine wave inputs, parallel resonance, and the nonresonant and the resonant transformer.

Principles of Industrial Measurements--A study of the more common sensing devices and components employed for the measurement of temperature, pressure, flow, and related phenomena. It is designed to coordinate with the material presented in PHYSICS FOR INSTRUMENTATION I.

Semi-Conductors & Vacuum Tubes--This course is designed as an introduction of vacuum tubes and semi-conductors, fundamentals, construction, and static and dynamic characteristics. A study will be made of multi-section and special purpose tubes. Semi-conductor devices such as diodes, transistors, and photo transistors will be studied.

Course Descriptions (continued)

Physics for Instrumentation I--Virtually all theories of measurement and control are based on certain principles of physics, changes of shape or dimension, magnetic variation, resistance modifications, or the effect of adding or removing energy for some set of conditions. Consequently, physics is perhaps the most fundamental of the courses in the curriculum, and the one which is most vital to a successful consideration of instrumentation and control. The subject matter which is included is essentially a study of mechanics and heat, but the presentation of the various subsections emphasizes the conditions which must exist if there are to be interchanges in energy.

Technical Mathematics II--This course is the second in a three-semester sequence of integrated mathematics covering selected topics in algebra, trigonometry, analytical geometry, and calculus. The student studies analytic geometry, and it should closely correlate with electronic courses.

Principles of Automatic Controls--This course is a basic consideration of automatic control theory, elementary control systems, and control problems. Emphasis is given to the concepts of feedback, and the process of the feedback loop.

Computer Principles & Controls--This course is designed to teach the student the principles and theories underlying the design and function of computers and computer systems. Consideration of the various types of computers, computing systems, and their applications is based upon an understanding of the preceding subjects studied. As the study proceeds from the historically simple computer to the complex installations which are becoming parts of control systems, it is necessary to consider the various types of computers and their abilities as well as their limitations. It is also necessary to become familiar with much auxiliary equipment, such as input-output devices, analog-to-digital and digital-to-analog units, data storage components, and the myriad types of switching and conversion apparatus which have become part of some modern systems. The advent of computer control of processes along with the use of numerical control for positioning and machine-tool operations, entirely aside from applications in the field of computation and data handling, imposes an ever greater demand upon the abilities of the instrumentation technician. The emphasis of the course is on process and position control.

Physics for Instrumentation II--This course is a continuation of Physics for Instrumentation I. Emphasis should always be on the principles of sound, light, and nuclear power as they relate to instrumentation. The use of laboratory equipment and experiments to teach applied principles, not individual mechanisms or devices, should also be emphasized.

Technical Mathematics III--This course is the third in a three-semester sequence of selected topics in algebra, trigonometry, analytical geometry, and calculus. The student studies the ideas and principles of both differentiation and integration are developed and applied to technical problems. The course concludes with an introduction to Fourier analysis as it applies to an electronic problem.

Course Descriptions (continued)

Technical Report Writing--This course emphasis is upon techniques for collecting and presenting scientific data by means of informal and formal reports, and specific types of technical papers. Forms and procedures for technical reports are studied and a pattern is established for all forms to be submitted in this and other courses.

Analytical Measurements--This course is a study of process analysis with emphasis on gas chromotography, pH, viscosity, and some of the other analytical measurements we make in process analysis.

Advanced Automatic Controls--This course is a study of the response of systems to instrumental control based upon consideration of the system components. Negative and positive feedback along with the implications of closed loop control are covered.

Electrical Power Supply & Amplifiers--This course is a study of energy-conversion devices used in the electrical field, AC and DC motors, AC and DC generators, motor starters, switches, circuit breakers, synchros and servo-mechanisms, and poly-phase equipment. Also studied will be the analysis and design of multistage transistor and vacuum tube amplifiers including compensation techniques and feedback principles.

Instrumentation Project--This course provides the time and the opportunity for the student to work on the design, fabrication, assembly, and testing of some instrument, test fixture, or other suitable device of his choice. Its purpose is to promote independent study, initiative, and the assumption of responsibility and work, without specific instruction upon initiation of the project. The student will draw upon all his previous courses of study in order to arrive at satisfactory project completion. It will be necessary for the student to select materials, means of fabrication, sizes and dimensions, tests, and evaluation of performance.

Chemistry for Instrumentation--This course should present the basic and underlying principles of chemistry employed in industrial and commercial applications with particular emphasis on the elementary principles required for instrumental analysis.

MECHANICAL TECHNOLOGY

FIRST YEAR

First Semester	Lecture	Lab	Credit
Manufacturing Materials	2	3	3
Engineering Problems	2	0	2
Physics I	3	3	4
College Algebra & Trigonometry	5	0	5
Communication Skills I	3	0	3
			17

Second Semester			
Manufacturing Processes I	1	6	3
Technical Drafting I	1	6	3
Physics II	3	3	4
Analytic Geometry & Calculus	5	0	5
Technical Writing	3	0	3
			18

SUMMER SESSION

Studies to meet specific requirements of States and Institutions (Government and History) to be included during the summer.

SECOND YEAR

First Semester			
Methods of Quality Control	2	3	3
Methods of Operation Analysis	3	3	4
Manufacturing Processes II	1	6	3
Statics & Mechanics	3	0	3
Mechanics of Materials	3	0	3
			16

Second Semester			
Process Planning	3	3	4
Plant Layout & Materials Handling	3	3	4
Production Problems	2	6	4
Hydraulics & Pneumatics	2	3	3
Industrial Organizations & Institutions	3	0	3
			18

COURSE DESCRIPTIONS

Manufacturing Materials--This course is designed to study modern industry and how it utilizes a variety of engineering materials with which the student in mechanical technology must be familiar. A study is made of the ferrous metals, non-ferrous metals, wood products, nonmetallic materials, miscellaneous materials, and their application to industrial uses. Special emphasis is given to new materials which have been developed through technological advances.

Engineering Problems--This course is a detailed study made of various production activities and the problems associated with them. Problems and cases are solved through the use of available data in texts and engineering handbooks. Discussion of each topic begins with a consideration of the nature of the problem and continues with a presentation of the detailed approach to be employed in its solution. Some problems deal with the analysis of the elements of production scheduling. Others deal with methods of determining production costs in terms of labor, material, and burden. Balancing work stations on production lines by graphic, as well as by mathematical means to achieve constant flow and calculating machine capacities to establish completion dates represent a major portion of the laboratory work. Simulated industrial office atmosphere permits student groups representing various departments and functions of production to work cooperatively to achieve common objectives. Constant use of blueprints throughout the course strengthens the ability of the student to visualize and to interpret them. The basic slide rule operations are introduced early in the course so that the student can use this tool to advantage in other courses.

Physics I--The objectives of this course extend beyond its immediate purpose of developing an understanding of the basic principles of mechanics and heat. Emphasis is placed in both laboratory and lecture upon the scientific method. Heavy reliance is placed upon material from mathematics courses and the use of the slide rule in computation of data in the laboratory.

College Algebra & Trigonometry--This course assumes the satisfactory completion of a minimum of one semester of high school algebra and is the first of two mathematics courses designed specifically for mechanical drafting and design technology. An integrated course in college algebraic and trigonometric problems that have direct practical application to the field of specialization will be utilized.

Communications Skills I--This course places emphasis throughout on exercises in writing, speaking, and listening. Analysis is made of each student's strengths and weaknesses. The pattern of instruction is directed principally to helping students improve skills in areas where common weaknesses are found. The time allotments for the various elements within major divisions will depend upon the backgrounds of the individuals in the class.

Manufacturing Processes I--An understanding of present-day manufacturing processes is of extreme importance to students in this technology. This course is designed to provide a background of knowledge covering the various manufacturing materials and the fundamental types of manufacturing methods as employed in cold working processes. Through lecture, demonstration, and practical applications the student is given the opportunity to become familiar with the various types of machine tools, tooling, measuring, and inspection procedures. Automation is introduced and information is presented to acquaint the student with the modern practices of numerical control for machine tools and the uses of transfer and special machines.

Course Descriptions (continued)

Technical Drafting I--This is a beginning course for students who have had little or no previous experience in drafting. The principal objectives are: basic understanding of orthographic projection; skill in orthographic, isometric, and oblique sketching and drawing; ability to produce accurate and complete detail and assembly working drawings; understanding of principles and appropriate applications of descriptive geometry; experience in using handbooks and other resource materials; elementary understanding of design principles in machine parts used as drawing projects; and use of simplified drafting practices in industry. A.S.A. standards are stressed. Interpretation of industrial sketches and prints is introduced when feasible.

Physics II--This is an introduction to electrical circuitry and equipment with emphasis on the concepts of electrical physics. The treatment of this subject as a mathematics-based science provides a basis for further study for those students who will require a greater depth of understanding in this area.

Analytics and Calculus--This course is a study of rectangular coordinates, the straight line and the conic sections, polar coordinates, and general equation of the second degree. It is also an introduction to analytical geometry of three dimensions. Trigonometry and algebra are continued and expanded to more advanced phases as required in the technology. Calculus is incorporated in a manner emphasizing concepts and principles rather than facility in manipulation.

Technical Report Writing--This course emphasis is upon techniques for collecting and presenting scientific data by means of informal and formal reports and specific types of technical papers. Forms and procedures for technical reports are studied and a pattern is established for all forms to be submitted in this and other courses.

Methods of Quality Control--This is an elementary approach to the techniques used in the control of the quality requirements of manufactured articles. The entire course is woven around a core which consists of the application of formulas and control charts. The main activities covered include sampling inspection techniques, use of inspection tools and instruments, construction and interpretation of Showhart control charts for variables, defects, and fraction defective. Concerted effort is put on the relationship of theoretical concepts to practical manufacturing operations and processes so that assignable causes and weaknesses in a process can be readily isolated and recognized.

Methods and Operations Analysis--Understanding of the techniques used in determining the best way of doing a specific piece of work is developed through the systematic study of methods, materials, tools and equipment for the purpose of finding the most economical way of doing the work, standardizing the methods and procedures to be followed, and determining the time required by an average worker to perform the various tasks. Laboratory activities include the analysis of the fundamental physical motions, the construction of various charts, the practice of dividing operations into elements, and time study observations. Additional experience is gained in recognizing and giving value to foreign elements, allowances, and performance rating, and in calculating average cycle time, minimum observations, and standard times.

Course Descriptions (continued)

Manufacturing Processes II--This course is designed to provide a background of knowledge covering the various manufacturing materials and the fundamental types of manufacturing methods as employed in hot working processes. Through lectures, demonstrations, and discussions the student becomes familiar with the various types of welding processes and their applications, with special machining operations such as ultrasonic, electrical discharge, electroarc, and chemical milling, and with bonding practices and the use of adhesives in modern manufacturing. Some emphasis is also given to metallurgical practices and procedures. Practical experience is gained by the student in performing simple arc and oxyacetylene welding operations, in producing simple mods, cores, and castings, and in basic heat treating, inspection, and testing, using both destructive and nondestructive methods.

Statics and Mechanics--This course is designed to develop a knowledge of the underlying principles of analytical mechanics. The student should understand the basic laws of statics and dynamics. The study of the geometry of motion (kinematics) and the study of the forces required to produce motion (kinetics) must be involved.

Mechanics of Materials--Study is made of the internal stresses and deformation of elastic bodies resulting from the action of external forces. The application of this principle of strength of materials is considered fundamental in the design of structures and machines. Emphasis is given to the analysis of the simple and combined stresses and properties of materials to meet the functional requirements in design. In this course, strength of such elements as riveted joints, beams, columns, shafts, and keys is determined.

Process Planning--This is a comprehensive study of the fundamental principles, practices, and methods of process planning. The responsibilities and range of activities normally associated with process planning are surveyed; as is the relationship of process planning to other manufacturing functions. The course is made more meaningful by constant reference to concrete examples--interpretation of charts, operation analysis and routing forms. Student participation is provided through selected case problems having single or multiple solutions. Additional classroom activities include the actual process planning of selected jobs in terms of description and the sequence of operations, tooling determination, setup time estimating, feed and speed calculations, and process and machinery selection.

Plant Layout and Materials Handling--Emphasis is placed upon the relationship between good plant layout and efficient materials handling. Evaluation of the site and planning of the factory building are done with consideration of transportation, shipping and receiving, power, heat, light, and air conditions. Selection and arrangement of production machinery, product and process layout schemes, techniques of making layouts, and balance and flexibility of operations are fully discussed. Study is also made of the basic packaging and materials protection methods along with intensive consideration of the specific types of equipment used in the movement of incoming, in-process, storage, and waste materials. The course centers upon the fundamental principles of materials handling and the factors affecting plant layout. These principles are therefore constantly referred to during laboratory activities which include developing the general overall layout, detailing each area, making scale models and arranging them, and drawing in the flow diagram for final evaluation.

Course Descriptions (continued)

Production Problems--A detailed study is made of various production activities and the problems associated with them. Problems and cases are solved through the use of available data in texts and engineering handbooks. Discussion of each topic begins with a consideration of the nature of the problem and continues with a presentation of the detailed approach to be employed in its solution. Some problems deal with the analysis of the elements of production scheduling. Others deal with methods of determining production costs in terms of labor, materials, and burden. Balancing work stations on production lines by graphic, as well as by mathematical means to achieve constant flow and calculating machine capacities to establish completion dates represent a major portion of the laboratory work. Simulated industrial office atmosphere permits student groups representing various departments and functions of production to work cooperatively to achieve common objectives. Constant use of blueprints throughout the course strengthens the ability of the student to visualize and to interpret them.

Hydraulics and Pneumatics--This is a study of the basic components of hydraulic and pneumatic systems and how they are combined to build up various circuits. The emphasis is on the use of hydraulics and pneumatics for power transmission and for control purposes. Both subject areas are treated as basic sciences with emphasis on mathematical analysis and the scientific method.

Industrial Organizations & Institutions--A description and analysis of the roles played by labor and management in the economy of the United States is presented. Approximately one-half of the classroom time is devoted to labor-management relations, including the evolution and growth of the American labor movement and the development and structure of American business management. A study is made of the legal framework within which labor-management relations are conducted and the responsibilities of each in a democratic system of government. The second half of the course pertains to labor-economics as applied to the forces affecting labor supply and demand, problems of unemployment reduction and control, and wage determination on the national, plant, and individual levels. Emphasis centers upon current practical aspects of our industrial society with historical references intended only as background material to interpret trends and serve as points of departure.

COMPUTER SCIENCE TECHNICIAN
(DATA PROCESSING)

The recent requirements of business, industry, and science have created a great demand for people skilled in the technical field of computer science. Many new industries in engineering, electronics, missiles, and manufacturing require data processing technicians who can work side by side with the engineer or scientist to help analyze the specific problems at hand and devise a way to instruct the computer to achieve the desired results.

FIRST YEAR

First Semester	Theory	Lab	Credit
Introduction to Data Processing	3	0	3
Auxiliary Equipment	3	3	4
Data Processing Math I	3	0	3
Principles of Accounting	3	0	3
Communication Skills I	3	0	3
			16

Second Semester			
Introduction to Programming	3	3	4
Data Processing Math II	3	0	3
Principles of Accounting II	3	0	3
Principles of Management	3	0	3
Communication Skills II	3	0	3
			16

SECOND YEAR

First Semester			
Computer Programming	3	3	4
Systems Development & Design	3	3	4
Data Processing Applications	3	3	4
Statistics	3	0	3
Cost Accounting	3	0	3
			18

Second Semester			
Data Communications	3	0	3
Advanced Programming	3	6	5
Field Experience & Projects	3	3	4
Operating Systems	3	0	3
Political Science	3	0	3
			18

First Semester

COURSE DESCRIPTIONS

Introduction to Data Processing--This course presents a general introduction to the concepts and the basic features of electronic computers. The major emphasis is directe toward general coverage of the field of computers and is not restricted to specific configuration. It describes the evolution of computer systems from manual methods to the stored program. Historical landmarks and development of data processing are studied to see how they have influenced the evolvement of current automatic equipment used in the processing of information.

The following basic functions of the stored program concept are studied: Introduction to problem organization, storage media, fundamentals of input-output operations and elementary programming techniques. Problems are studied to learn how organization helps the solution. Flow charting is studied, in connection with problem solving, as a device to use in the process of segmenting problems into parts for ease of solution. Types of command structures are studied to obtain an understanding of how people instruct a computer. Programming techniques are covered so that the student will be able to apply future knowledge directly to programming ability. This course is to provide a good knowledge of fundamentals on which to build future knowledge into problem solving techniques.

Auxiliary Equipment--Computer loands and expensive time charges dictates the necessity of directing phases of problem solution procedures to the less expensive punched card equipment generally located in computer installations. The programmer for proper applications must be aware of the capabilities of such equipment and understand its relationship to the central processor.

The first idea of a "system" is imparted in this course because several machine (functions) make up a unit record installation capable of combining these parts (functions) into a problem solving process. The course is designed to present fundamental concepts, capabilities and limitations of the perpherial equipment commonly associated with computer systems.

Data Processing Math I--This course presents concepts of rotation, basic algebra, and number systems. It also covers representation of a number with an arbitrary base, fixed and floating point numbers, precision and significance, and linear equations.

Principles of Accounting--This course emphasizes the principles, techniques, and tools of accounting. It provides the necessary background understanding of the mechanics of accounting--collecting, summarizing, analyzing, and reporting information about the business. As the mechanics of accounting become well formulated, it is practical to introduce the use of data processing machines in performing the accounting functions within an organization. Case studies are used to effectively impart these concepts.

Course Descriptions (continued)

Communications Skills I--This course places emphasis throughout on exercises in writing, speaking and listening. A basic language study is made involving grammer, punctuation, and spelling skills with frequent exercises in the development of accurate and precise sentences and paragraphs. Emphasis on composition is given in the area of practical application. Analysis is made of each student's strengths and weaknesses. The pattern of instruction is directed principally to helping students improve skills in areas where common weaknesses are found. The time allotments for the various elements within major divisions will depend upon the backgrounds of the individuals in the class.

Second Semester

Introduction to Programming--This course contains a survey of computer theory to provide a foundation for future detail study of systems. One of the primary objectives is to develop elementary problem solving techniques (Problem Oriented Programming Language may be utilized) that will be reinforced and expanded by the student as he continues to learn other programming languages. The language used as the elementary problem solving technique will serve as the carrier of concepts and programming abilities for the remainder of programming activities in this curriculum. The student will also study the functions and capabilities of a specific data processing machine and will become familiar with some of the tools and raw materials necessary for becoming a programmer.

Data Processing Math II--This course is a study of the functions of acute angles, equivalent functions for any angle, logarithms, use of tables, arithmetic and logarithmic solution of right and oblique triangles and related figures, areas, identities, solution of trigonometric equations, radian measure, graphs of functions, and unit circle.

Principles of Accounting II--This course emphasizes management uses of accounting information. The emphasis is on accounting as a source of data for management control rather than on bookkeeping skills. Accounting services are shown as they contribute to the recognition and solution of a management problem. The concept of performing accounting services on data processing machines is emphasized throughout the course through the use of case studies.

Principles of Management--A basic study is given to the elements necessary for management action and how these elements can be implemented for organizational effectiveness.

The student is introduced to management as a distinct activity. The characteristics and fundamental concepts and the need for a sound management philosophy are examined. Studied in this course are areas such as planning, organizing, directing, and controlling objectives, policies, functions, and procedures; line and staff functions, authority and responsibility, informal organization and structure, human relations, morale, motivation, grievances, and disciplinary action and communication. It is a study of the relationships of economic factors in industry as they relate to labor and management.

Communication Skills II--The nature and dynamics of communication are contingent in this course. The fundamental concepts treated here have important implications for organizations of all types--business, industrial, Government, military, social, public, and civic. This course is devoted to the practical uses of the communication process within the business organization and, in particular, within the data processing department.

First Semester - SECOND YEAR

Computer Programming--This course continues the study of computer programming with special emphasis on multiple tape programs and the fundamentals of random access programming. There is additional study in practice and graphic representation of problem solution - flow charting and block diagram. Computer operated systems utilizing compiler languages are studies. Select programs will be written, compiled, and executed using COBOL (common oriented business language) and/or FORTRAN (formula translation)

Systems Development & Design--The effective use of data processing equipment and management sciences in meeting the information needs of business and industry requires that much skill and knowledge be applied to the development and design of data processing systems. The course is designed to guide the student through the three stages in the evolution of a system: Analysis of present information flow, system specifications and equipment selections, and implementation of the system.

The scope of a system development study will vary from a modest payroll procedure to the total information system of a large and complex organization.

Data Processing Applications--This course is designed to acquaint the student with specific data processing applications. Practical case studies illustrate the use of data processing equipment in various types and sizes of representative companies. The students apply their knowledge and understanding of machine data processing systems.

Statistics--The objective of this course is to present to the student the fundamental concepts of statistics in a manner which will indicate the relationship between statistical procedures and computer solutions. It also presents mathematical and statistical techniques to illustrate how programming can be more logically applied. This enables the student to recognize the immediate application of learned concepts.

Cost Accounting--An understanding of the basic concept of the cost accounting function within a manufacturing organization is the objective of this course. Material costs, labor costs, manufacturing overhead, and marketing costs that enter the cost accounting system are treated in detail. The use of the computer as a tool for performing the cost accounting function through the collection, processing, and interpretation of these data for providing management with pertinent facts about its business is stressed through case studies selected to illustrate the objectives of the cost accounting system, its relationship to the overall accounting system, and its uses to management.

Second Semester

Data Communications--This course is concerned with the basic principles involved in the transmission of data over various media of communications. Such as, tele-type, voice grade, broad band, micro-wave, telpack, etc. It discusses the equipment requirements, types of communications media, interfacing equipment and devices, types of systems, physical restrictions in the communication of data, rates and charges for various types of communication media, time-sharing multi-programming-multi-processing, new devices and

Course Descriptions (Continued)

terminals, etc. The students are required to develop the plans for a basic data communications system outlining type of system, equipment, type of communications, costs, etc.

Advanced Programming--The objective of the course is to provide the student with sufficient knowledge of programing systems concepts so that he may easily master any specific system with a minimum of instruction. Furthermore, he will be qualified to analyze, evaluate, and make modifications to such systems. Individual phases of certain selected systems are treated in detail (such as assembler language, machine-oriented language, compiler language, Macro-Generators, Report Generators, File processing, sorts, merges, Simulators, etc.) in order that the student may learn advanced programing and logic decision techniques as applied in sophisticated systems. The course is so designed that the student may gain an insight into the various functions of advanced programing systems and the manner in which they perform their tasks without learning the actual programing language of the various systems.

Field Experiences & Projects--This course is highly personalized in the sense of individual students activity and interest. Assignments are selected on the basis of interest expressed by the student and instructor evaluation of prior academic performance. Emphasis is directed toward the solution of meaningful problems or applications which require command of the total system concepts.

Operating Systems--This course emphasizes monitors supervisory systems and input-output control systems. Discussion of the basic principles of storage sharing, program control, compilers, assemblers, and translators is involved. The general features of information, model, and conditional macro-instructions are examined. Coverage is given to special purpose routines, general purpose routines, dispatching routines and buffering. Additional coverage is given to sequence of operations, error handling, requirements for a tape system and requirements for a random access system.

Political Science--This course is oriented to the proposition that each technician in a democracy has a responsibility to make a productive contribution toward the perfection and perpetuation of the American way of life; and that, to do so, he must know and understand his responsibilities and obligations to himself, his family, his community, his State and Nation, and the world. The elements of government are reviewed to help the student achieve a good working understanding of his total environment and the forces which interact to form the social setting in which he works and lives.

SUMMARY

The material developed and the exchange of ideas in the curriculum sections were lightly constructive; however, a very significant development occurred at the workshop that was not expected in the original planning of the workshop. Some of the industrial representatives were discussing the problems of having technical education programs accredited by various accrediting organizations when a group of the participants at the workshop presented the idea of developing a southwestern technical education association to serve the five States in Region VII that would have as one of their official functions an accrediting function. It was felt by the participants that sufficient expertise existed within Region VII to properly evaluate and accredit these technical programs. The technology would be evaluated on standards set for that technology by the association and accredited by the association when these standards had been met. The association would start the evaluation and accrediting procedures only at the written request of the educational institution. The review panel would consist of a specialist in the technical field from each of the five states in the Region, a minimum of three industrial representatives knowledgeable in that technology, the State official in charge of technical education for that State, and Federal personnel representing technical education for the regional office of the U. S. Office of Education.

Through the cooperative efforts of the States, institutions, and organizations involved in an association of this type, many benefits may be developed. It was the hope of the participants at the workshop that this association could be a realistic instrument for the development of technical education as defined earlier in the report.

Based upon the analysis of the special abilities, established by the participants at the workshop, which technicians must have, and the level at which they must exercise them in performing the various activities characteristically required of them. It is clear that technician education must be of college level and intensity. To be administrable, the total learning program must be divided into a series of courses in which all that must be learned may be most advantageously taught. The total series of courses, their sequential arrangement, and the details of the plan for teaching each course, constitute the curriculum.

The development of the technical education curriculums and the material found in this report should be directly attributed to the exceptional contributions made by individuals on the panels which consisted of industrial representatives and technical educators, and the participants in general. The roster of these individuals is enclosed in Attachment "A".

ATTACHMENT "A"

PARTICIPANTS AT THE TECHNICAL EDUCATION CURRICULUM WORKSHOP
IN LOS ALAMOS, NEW MEXICO, AUGUST 7-11, 1967

ROSTER

Joe W. Ables
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Los Alamos, New Mexico

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